THE NATIONAL POLAR-ORBITING OPERATIONAL ENVIRONMENTAL SATELLITE SYSTEM DELIVERING GLOBAL DATA FOR IMPROVED NUMERICAL WEATHER PREDICTION

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Abstract - The tri-agency Integrated Program Office (IPO) is responsible for managing the development of the National Polar-orbiting Operational Environmental Satellite System (NPOESS). NPOESS will replace the current Defense Meteorological Satellite Program (DMSP) and Polar-orbiting Operational Environmental Satellites (POES) that have provided global data for weather forecasting for over 40 years. Beginning in late 2009, NPOESS spacecraft will be launched into three orbital planes to provide significantly improved operational capabilities and benefits to satisfy critical civil and national security requirements for space-based, remotely sensed environmental data. NPOESS will observe significantly more phenomena simultaneously from space than its operational predecessors and deliver a data volume significantly greater than the current POES and DMSP systems with substantially improved data latency. Higher (spatial, temporal, and spectral) resolution and more accurate sounding data will support continuing advances in data assimilation systems and numerical weather prediction models to improve short- to medium-range weather forecasts. NPOESS will support the operational needs of civilian meteorological, oceanographic, environmental, climatic, and space environmental remote-sensing programs. With the development of NPOESS, we are evolving operational "weather" satellites into integrated environmental observing systems by expanding our capabilities to observe, assess, and predict the total Earth system - atmosphere, ocean, land, and the space environment.

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1. INTRODUCTION

Over the last ten years, the tri-agency Integrated Program Office (IPO), comprised of the Department of Commerce's (DOC) National Oceanic and Atmospheric Administration (NOAA), the Department of Defense (DoD), and the National Aeronautics and Space Administration (NASA), has been managing the development of the National Polar-orbiting Operational Environmental Satellite System (NPOESS). Once operational later this decade, NPOESS will replace the current NOAA Polar-orbiting Operational Environmental Satellite (POES) and DoD's Defense Meteorological Satellite Program (DMSP) systems, each with over a 40-year heritage of successful service. With the development of NPOESS, we are evolving the existing "weather" satellites into an integrated environmental observing system by expanding our capabilities to observe, assess, and predict the total Earth system – ocean, atmosphere, land, and the space environment. Data from the advanced NPOESS sensors will enable more accurate short-term "nowcasts" and short- to medium-range forecasts as well as serve data continuity requirements for improved global climate change assessment and prediction.

The IPO, through its Acquisition and Operations (A&O) contractor, Northrop Grumman Space Technology (NGST), will begin to launch NPOESS spacecraft in late 2009 into three orbital planes (1330, 1730, and 2130 equatorial ascending nodal crossing times) to provide a single, national system capable of satisfying both civil and national security requirements for space-based, remotely sensed environmental data. NGST, with its teammate Raytheon, is responsible for developing, integrating, deploying, and operating NPOESS satellites to meet the tri-agency requirements for NPOESS over the 10-year operational life of the program.

2. REQUIREMENTS

The planned evolution from the current POES and DMSP programs to NPOESS will take place over the next five to nine years. Currently the U.S. is operating two primary POES and two primary DMSP satellites. The first launch of an NPOESS spacecraft is planned for November 2009 to begin replacing the last of the current POES and DMSP satellites. When NPOESS reaches full operational capability in 2013, spacecraft in all three orbital planes will provide global coverage with a data refresh rate of approximately four hours for most observations.

The tri-agency partners in the NPOESS program have agreed upon a fully defined set of integrated operational requirements that will meet the needs of the United States' civil and military users for operational satellite data in the next decade. The military and civilian user communities jointly defined Environmental Data Records (EDRs), as well as the required performance characteristics for each of these data products. The 55 (including active fires) NPOESS Environmental Data Records, shown in Figure 1, fully encompass the Earth science disciplines. This figure displays the full set of EDRs allocated by sensor that will be available as global data (Stored Mission Data). Subsets of these data will also be broadcast in real-time at low (Low Rate Data) and high (High Rate Data) rates to

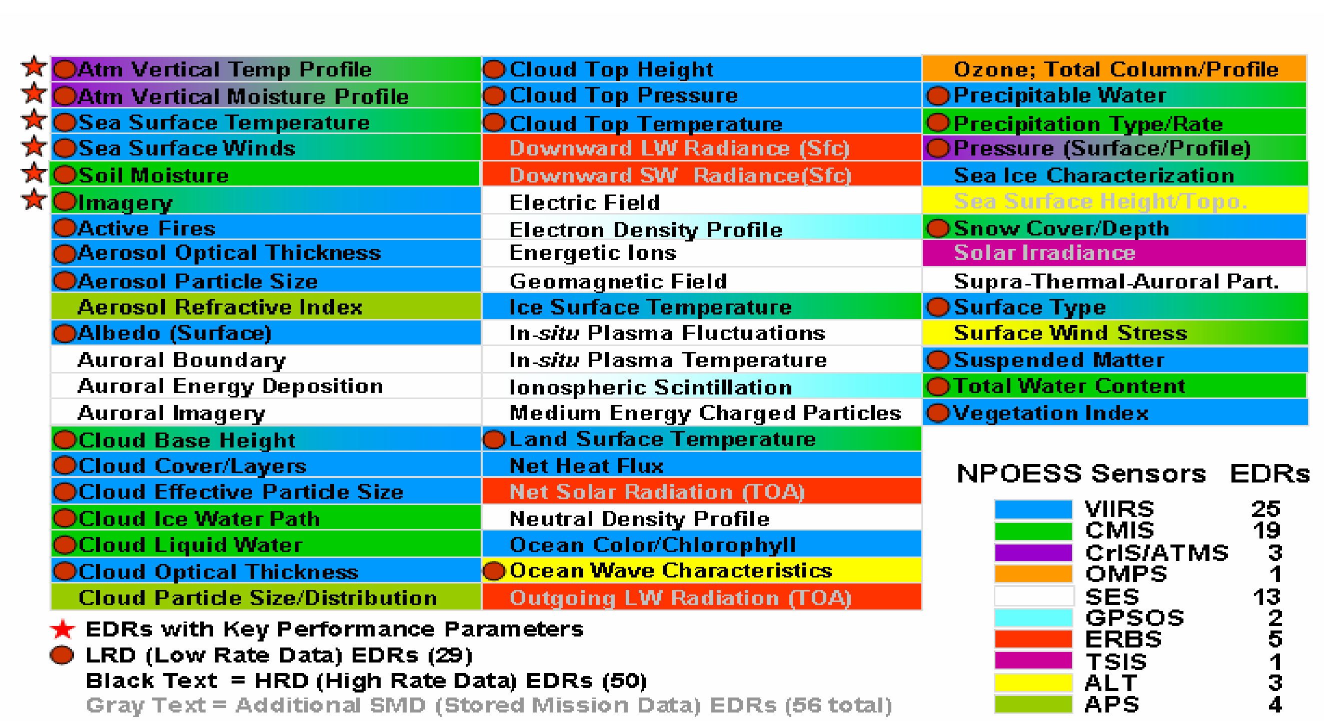

Figure 1. NPOESS Environmental Data Records (EDRs) by sensor

field terminals worldwide. When operational, NPOESS will truly be an "environmental observing system."

There are six EDR's with Key Performance Parameters (KPPs) which are given the highest priority. They include: (1) atmospheric vertical temperature profile; (2) atmospheric vertical moisture profile; (3) sea surface temperature; (4) sea surface winds (speed and direction); (5) soil moisture; and (6) cloud and ice imagery. These KPPs are so significant that failure to meet threshold performance is cause for the system to be reevaluated or the program to be reassessed or terminated. Atmospheric temperature and moisture sounding data top the list of NPOESS requirements. The increases in data accuracy, resolution, areal coverage, and quality that will be realized from the advanced sounders are expected to lead to significant improvements in numerical weather prediction (NWP) products in the next decade.

Performance characteristics for each of the 55 EDRs were defined and bounded between threshold values that represent minimally acceptable performance for an attribute and objective levels that represent performance that would have significant added value to users. In many cases, threshold values were set to meet or exceed what can be achieved from instruments on current operational satellites (i.e., POES and DMSP). The specific attributes include horizontal (vertical) resolution, mapping accuracy, measurement range, measurement precision, measurement uncertainty, refresh rate, data latency, and geographic coverage. Long-term stability requirements have also been established for key parameters (e.g., atmospheric vertical temperature, sea surface temperature, sea surface winds) to ensure temporal consistency and continuity of data over the life of NPOESS that will support improved global climate change assessment and prediction. These stability requirements have necessarily influenced the design and performance of the advanced technology sensors that are being built for NPOESS, and are guiding the development of the calibration/validation activities that will extend throughout the life of the NPOESS program. The technical requirements for the complete set of 55 EDRs are fully described in the Integrated Operational Requirements Document-II (IPO, 2002).

3. INSTRUMENTS AND SYSTEM DEVELOPMENT

The established requirements for 55 atmospheric, oceanic, terrestrial, climatic, and solar-geophysical parameters are guiding the development of advanced technology visible, infrared, and microwave imagers and sounders that will provide enhanced capabilities to users and improve the accuracy and timeliness of observations. In 1997, the IPO initiated multiple risk reduction contracts that were focused on early development of the critical sensor suites and algorithms necessary to support NPOESS. In August 2001, preliminary design efforts were completed for the last of five critical imaging/sounding instruments for NPOESS. Final design, prototype development, and fabrication of these instruments have begun, with delivery of the first flight units for four sensors scheduled for 2005 to support the NPOESS Preparatory Project. In 2000, the IPO initiated a program definition and risk reduction phase to define the NPOESS total system architecture, including space, ground processing, and command, control, and communications components, as well as to develop specifications for sensor/spacecraft integration. This phase of the early development program was concluded in August 2002 with the award of a single prime contract to Northrop Grumman Space Technology to accomplish the Acquisition and Operations of NPOESS. NGST is responsible for delivering the "end-to-end" system consisting of: the spacecraft; instruments and sensors on the spacecraft; launch support capabilities; the command, control, communications, and data routing infrastructure; and data processing hardware and software.

The operational weather forecasting and climate science communities have levied more rigorous requirements on space-based observations of the Earth's system. These requirements have significantly increased demands on performance of the instruments, spacecraft, and ground systems required to deliver NPOESS data, products, and information to end users. NPOESS instruments will observe significantly more phenomena simultaneously from space than its POES and DMSP predecessors. NPOESS will deliver more accurate measurements at higher spatial (horizontal and vertical) and temporal resolution to support operations and research. User demands for more real-time data from NPOESS are driving the space and ground-based architectures for data routing and retrieval that will dramatically shorten data latency (time from observation by the satellite to availability of processed EDRs). NPOESS will deliver data from its advanced technology visible, infrared, and microwave imagers and sounders at higher data rates with more frequent space-to-ground data communications. Most of the NPOESS sensors are considerably more complex than the instruments carried on either DMSP or POES. NPOESS is expected to deliver a total data volume of approximately 8 terabytes per day which is significantly greater than the current POES and DMSP systems. This significant increase in data volume will necessarily increase demands on the front-end processors and data assimilation systems used to initialize and update global and regional NWP models.

Thirteen different instrument payloads will be flown on NPOESS spacecraft in three different configurations, depending upon orbit. Details on each of the 13 instrument payloads are available in Cunningham et al (2003). Figure 2 shows the spacecraft and instrument configuration for the NPOESS satellite that will fly in the 1330 ascending orbit.

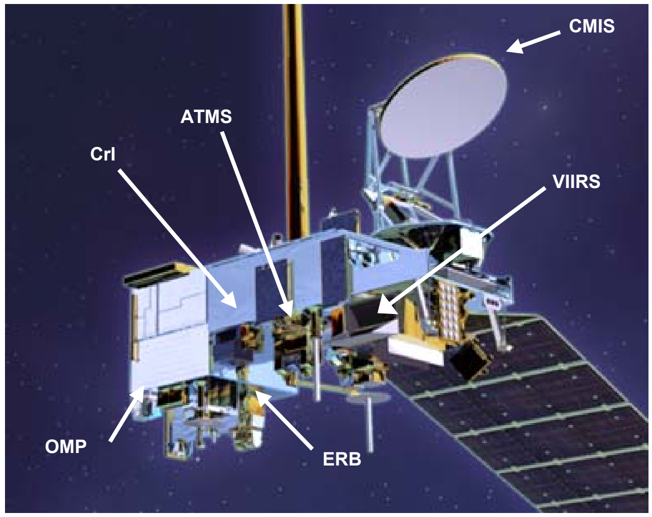

Figure 2. NPOESS spacecraft and instrument configuration for 1330 (equatorial ascending nodal crossing time) orbit

NPOESS payloads include instruments to: 1) profile the atmosphere (Cross-track Infrared Sounder [CrIS], Advanced Technology Microwave Sounder [ATMS], Ozone Mapping and Profiler Suite [OMPS], and Aerosol Polarimetry Sensor [APS]); 2) probe the space environment (Global Positioning System Occultation Sensor [GPSOS] and Space Environment Sensor Suite [SESS]); 3) monitor the Earth's radiation budget (Total Solar Irradiance Sensor [TSIS] and Earth Radiation Budget Sensor [ERBS]); 4) map the ocean surface (radar altimeter [ALT]); and 5) observe atmospheric, terrestrial, and oceanic phenomena globally (Visible/Infrared Imager Radiometer Suite [VIIRS] and Conical-scanning Microwave Imager/Sounder [CMIS]).

The advanced atmospheric sounders on NPOESS (CrIS and ATMS) constitute the Cross-track Infrared and Microwave Sounding Suite (CrIMSS). The CrIS is a Fourier Transform Spectrometer that uses a Michelson interferometric sounder capable of sensing upwelling infrared radiances from 3 to 16 μm at very high spectral resolution (~1300 spectral channels) to determine the vertical atmospheric distribution of temperature, moisture, and pressure from the surface to the top of the atmosphere across a swath width of 2200 km. CrIS uses an array of 9 Fields of View (FOV), each 14 km in diameter and each spanning 3 infrared bands. CrIS will succeed the Atmospheric Infrared Sounder (AIRS) which is on NASA's Earth Observing System (EOS) Aqua spacecraft. Bloom (2001) provides additional details on CrIS. The ATMS is the next generation cross-track microwave sounder that will combine the capabilities of current generation microwave temperature sounders (Advanced Microwave Sounding Unit - AMSU-A) and microwave humidity sounders (AMSU-B) that are flying on NOAA's POES and NASA's EOS Aqua spacecraft. The ATMS draws its heritage directly from AMSU-A/B, but with reduced volume, mass, and power. The ATMS has 22 microwave channels to provide temperature and moisture sounding capabilities in the 23/31, 50, 89,150, and 183 GHz spectral range. Sounding data from CrIS and ATMS will be combined to construct atmospheric temperature profiles at 1° K accuracy for 1 km layers in the troposphere and moisture profiles accurate to 15 percent for 2 km layers.

Higher (spatial, temporal, and spectral) resolution and more accurate sounding data from CrIS, ATMS, and CMIS will support continuing advances in data assimilation systems and NWP models to improve short- to medium-range weather forecasts. The VIIRS will deliver real-time high resolution, radiometrically accurate data on surface albedo, land surface type, sea surface temperature, snow cover, and ice extent for ingesting into global and regional models. The OMPS will profile ozone vertically in 3 km layers to provide better specification of stratospheric ozone that is now being used as a tracer in global NWP models.

Data from multiple instruments will be required to derive certain parameters. In particular, "all-weather" requirements for selected EDRs will be met by combining near-simultaneous infrared (from VIIRS) and microwave (from CMIS) measurements to derive global and regional products (e.g., SST). In addition, NPOESS will carry forward the current capabilities on POES for search and rescue (Search and Rescue Satellite Aided Tracking System [SARSAT]) and surface data collection/location (Advanced/Data Collection System [A-DCS] also know as ARGOS) that are important to a broad user community for relaying data from fixed and mobile, oceanic and terrestrial platforms. Fault tolerant designs for each of the instrument payloads will enable long mission life (up to 8 years storage and 7 years operation) to ensure mean mission durations exceeding five years for each of the NPOESS spacecraft over the operational life of the program (2009-2019). This is a significant improvement over the average on-orbit life of POES or DMSP spacecraft (36-48 months) and comparable to what NASA is currently achieving in its EOS missions. Longer on-orbit life also means that fewer spacecraft will be required to provide coverage over the 10-year span of NPOESS operations.

The current operational concept for NPOESS consists of a constellation of spacecraft flying at an altitude of 828 km in three sun-synchronous (98.7 degree inclination) orbital planes with equatorial ascending nodal crossing times of 1330, 1730, and 2130 local solar time respectively. NPOESS spacecraft are being designed for precise orbit control to maintain altitude, nodal crossing times to within $\pm$10 minutes throughout the mission lifetime, and repeat ground tracks to $\pm$1 km (repeat cycles of ~17 days) for certain measurements (e.g., sea surface height). Because the user-specified requirements for data refresh are different for many of the 55 environmental parameters, not all instrument payloads are required in each orbit. In addition, certain orbital characteristics (e.g., the terminator orbit is not conducive to certain measurements), as well as considerations of instrument field of view on the spacecraft have determined the payload configurations for each orbit. The afternoon (1330 ascending) spacecraft will carry the largest complement of instruments. The early-morning (0530 descending) and mid-morning (0930 descending) NPOESS spacecraft will carry reduced complements of instruments, including VIIRS and CMIS that are required to meet the stringent U.S. horizontal resolution and data refresh (four hours) requirements for "all-weather" imaging (visible/infrared and microwave) and ocean surface wind field mapping in these orbits. As a result of discussions between NOAA, the IPO, and the European Organisation for Exploitation of Meteorological Satellites (EUMETSAT), the CrIS and ATMS instruments that were manifested for the 0930 (descending) orbit (as originally proposed by NGST to meet U.S. user requirements for temperature and moisture sounding data in that orbit) have been shifted to the 0530 (descending) orbit. Sounding data acquired from the Infrared Atmospheric Sounding Interferometer (IASI) and the Microwave Humidity Sensor (MHS) on EUMETSAT's Metop satellite in the 0930 (descending) orbit will be used to meet the requirements for atmospheric temperature and moisture sounding data in this orbit. The current orbit manifest for the NPOESS sensor payloads is shown in Table 1.

Table 1. NPOESS instrument payloads by orbit

EQUATORIAL ASCENDING NODAL CROSSING TIME

1330	1730	2130
VIIRS	VIIRS	VIIRS
CrIS	CrIS	
ATMS	ATMS	
CMIS	CMIS	CMIS
OMPS		
GPSOS		
SESS	TSIS	
ERBS	ALT	APS
SARSAT	SARSAT	SARSAT
A-DCS	A-DCS	

4. EARLY SYSTEM TESTING

Previous experience in developing and operating complex environmental satellites has shown that rigorous pre-flight testing is essential to ensure success. End users must also be prepared in advance to accept, use, and benefit from the full economic and scientific value of the data streams from new systems.

WindSat

Early flight-testing of instruments is a critical part of the NPOESS program to reduce development risk and to demonstrate and validate global imaging and sounding instruments, algorithms, and pre-operational ground processing and distribution systems prior to the first NPOESS launch in late 2009. The joint DoD/IPO Coriolis/WindSat mission was launched in January 2003 to provide a space-based test and demonstration of passive microwave polarimetric techniques to derive measurements of ocean surface wind direction in addition to the surface wind speed previously available from the Special Sensor Microwave Imager (SSM/I). Preliminary results from the first eighteen months of on-orbit operations of WindSat have demonstrated excellent radiometric functionality and improved spatial resolution over the SSM/I on DMSP. Recent test images produced for the complete Stokes Vector from the vertically, horizontally, and circularly polarized data demonstrate that space-based passive polarimetry will measure both wind direction and wind speed successfully. This planned three-year mission continues the development of improved microwave measurement capabilities from the Special Sensor Microwave Imager and Sounder (SSMI/S) on the remaining DMSP spacecraft to CMIS on NPOESS. CMIS will be flown in all three NPOESS orbits to provide higher spatial and temporal resolution mapping of the ocean surface wind field.

NPOESS Preparatory Project

The joint IPO/NASA NPOESS Preparatory Project (NPP), that will be launched in October 2006, will carry four of the critical NPOESS sensors (VIIRS, CrIS, OMPS, and the NASA-developed ATMS) to provide on-orbit testing and validation of sensors, algorithms, and ground-based operations and data processing systems while the current operational POES and DMSP and the NASA EOS research satellite systems are still in place. Although NPP will be launched after the expected lifetime of NASA's Terra mission (December, 2005), it will be in orbit well in advance of the expected lifetimes of Aqua (April, 2008) and Aura (January 2010). In addition to ATMS, NASA is providing the NPP spacecraft that is being built by Ball Aerospace and Technologies Corporation, as well as the launch vehicle. The IPO is responsible for the VIIRS, CrIS, and OMPS instruments, NPP spacecraft operations, and ground processing systems.

The IPO, in cooperation with the Norwegian Space Centre (NSC) has installed a 13-meter antenna at Svalbard, Norway as the primary data downlink site for global stored mission data from NPP. Svalbard is located at high enough latitude (78 degrees north) to be able to "see" all 14 daily NPP satellite passes. In addition to the stored data, NPP will broadcast real-time data at X-band frequencies (7750-7850 MHz) to users equipped with appropriate field terminals. The global data will be transmitted from Svalbard within minutes to the U.S. via a fiber-optic cable system that was completed in January 2004 as a joint venture between the IPO, NASA, and the Norwegian Space Centre. The new antenna and fiber-optic link are already being used to bring down data from 5 to 10 Coriolis/WindSat passes per day and deliver the data to users in a reliable and timely manner. The Svalbard site will be ready for NPP ground system readiness in December 2004. Subsequent to the NPP mission, the Svalbard site and the high-speed fiber-optic link will serve as one node in a distributed ground data communications system for NPOESS.

The NPP mission will provide operational agencies early access to the next generation of operational sensors, thereby greatly reducing the risks incurred during the transition from POES and DMSP to NPOESS. Early system-level integration and testing will provide "lessons learned" and allow for any required modifications in time to support readiness for the first NPOESS launch. Development risk for the NPOESS ground system is being reduced through early delivery and testing of the NPP ground system (a subset of the NPOESS architecture). NPP will generate approximately 1.5 terabytes of data per day, which is similar to the current data volumes from EOS Terra and Aqua. The four sensors on NPP will provide 80 percent of the data rate assigned to all fourteen sensors on NPOESS and acquire data for 25 of the 55 NPOESS EDRs. This will be a significant step toward completing the data handling processes needed to accommodate even more data when NPOESS comes on-line. Extensive pre-launch and on-orbit calibration and validation of instruments on NPP and early user evaluation of NPOESS data products will allow for modifications to algorithms prior to the first NPOESS launch in 2009. Early access to and evaluation of data from NPP will ensure that data from NPOESS will be incorporated into NOAA and DoD operations soon after its availability.

NPP will demonstrate the utility of improved imaging and sounding data in short-term weather "nowcasting" and forecasting and in other oceanic and terrestrial applications, such as harmful algal blooms, volcanic ash, and wildfire detection. In addition to serving as a valuable risk reduction and prototyping mission for the IPO, NPP will provide continuity of the calibrated, validated, and geo-located NASA EOS Terra and Aqua systematic global imaging and sounding observations for NASA Earth Science research. With a five-year design lifetime, NPP will provide a "bridge" from NASA's EOS research missions (Terra, Aqua, and Aura) to the operational NPOESS mission. NPP will extend the series of key measurements in support of long-term monitoring of climate change and of global biological productivity.

5. PREPARING FOR THE FUTURE

From its beginnings, the IPO has funded special projects to demonstrate new imaging and sounding instruments, algorithms, and ground data processing systems to reduce risk for major science and technical issues that need to be resolved prior to the first NPOESS launch. These projects include development of specialized airborne systems, such as the NPOESS Airborne Sounder Testbed (NAST), as well as collaborative efforts to build capabilities to use advanced sounding and imaging data for improved weather forecasting.

NAST consists of infrared and microwave sounders flying on the NASA ER-2 and Proteus research aircraft that are being used to test and validate the measurement technologies for the CrIS and ATMS instruments on NPOESS. Data collected from NAST are being used to evaluate the algorithms that will be used to derive atmospheric temperature and moisture profiles from CrIS and ATMS. After NPP is launched in 2006, NAST will provide "ground-based" (underflight) measurements for sustained calibration and validation of the space-based instruments.

To complement NAST, the IPO has been sponsoring scientists at NOAA's National Environmental Satellite, Data, and Information Service (NESDIS) for the past five years to develop a processing system for real-time advanced sounder data to improve numerical weather prediction. This effort is focused on establishing efficient methods for processing SDRs and EDRs from CrIS and effectively using high spectral resolution infrared data in NWP models. As a proof-of-concept for CrIS, data from AIRS on NASA's Aqua spacecraft are being processed operationally and delivered to NWP centers for evaluation. The system is being designed to process data from the succession of current and future advanced atmospheric sounding instruments (i.e., AIRS, IASI, and CrIS). This project is one of several major preparatory activities being conducted by the multi-agency (NASA-NOAA-DOD) Joint Center for Satellite Data Assimilation (JCSDA), which is partially funded by the IPO, to prepare for data from NPOESS. Preparation for the use of AIRS (and later CrIS) radiance data in NWP models is a high priority for the JCSDA. The increased data quality and volume available during the NPOESS era, coupled with JCSDA efforts to build the scientific and computational infrastructure necessary to use the data, will result in significant improvements in NWP products in the next decade.

6. GROUND SYSTEMS

Global Data

To meet U.S. user-validated requirements for 55 geophysical parameters, including specific DoD and NOAA user requirements for data latency, the NPOESS Command, Control, and Communications Segment (C^3S) will deliver global Stored Mission Data (SMD) to four U.S. Operational Processing Centers (OPCs) for processing and distribution to end users: NOAA's National Environmental Satellite, Data, and Information Service (NESDIS) that will serve the National Centers for Environmental Prediction (NCEP); the Air Force Weather Agency (AFWA); Fleet Numerical Meteorology and Oceanography Center (FNMOC); and the Naval Oceanographic Office (NAVOCEANO). Global data will be down-linked to 15 globally-distributed, low-cost, unmanned ground stations that will be tied to the OPCs via commercial fiber-optic networks. This innovative "SafetyNet*" (patent pending technology) ground system (Figure 3) is being developed by the NGST/Raytheon team to deliver 75% of the SMD (daily average) to OPCs within 15 minutes and 95% of the data (daily average) within 28 minutes from the time of on-orbit collection. This is a dramatic improvement over the ~120-180 minute data latency for global stored data from POES and DMSP. Improved data latency, more frequent data refresh, and enhanced global coverage from NPOESS should facilitate more rapid updates to regional and mesoscale forecast models.

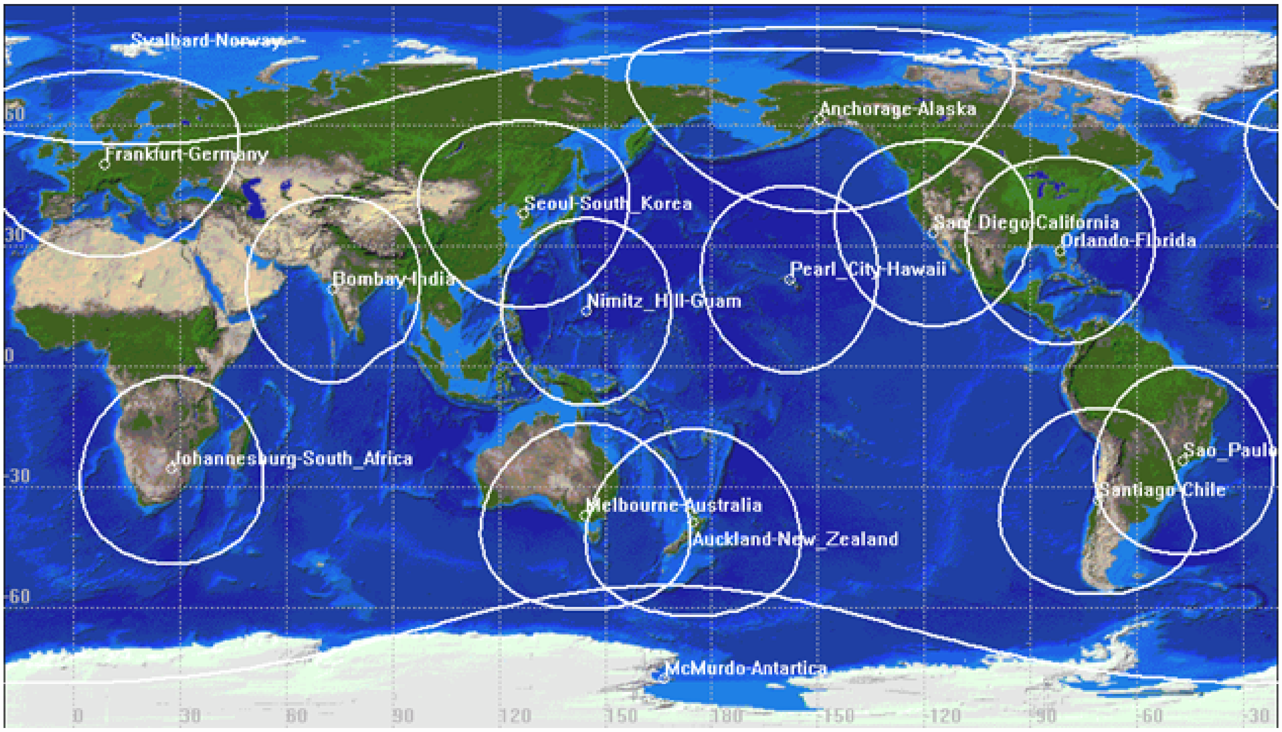

Figure 3. NPOESS will use SafetyNet*, a globally distributed network of 15 unmanned, low-cost ground receptors

NPOESS global data will be the complete, full resolution data set containing all sensor data and auxiliary data necessary to generate all NPOESS Environmental Data Records at the OPCs. Each OPC will be equipped with an Interface Data Processing Segment (IDPS) consisting of the necessary data ingest and computational hardware and software to process NPOESS Raw Data Records (RDR) into Sensor Data Records (SDRs) and EDRs, using auxiliary and ancillary data as necessary. Raw Data Records (Level 0/1A) will be full resolution, unprocessed sensor data, time-referenced, with earth location, radiometric and geometric calibration coefficients appended, but not applied, to the data. Sensor Data Records (Level 1B) will be full resolution sensor data that are time referenced, earth located, and calibrated, inclusive of radiance data that are now being used more effectively to initialize NWP models. Environmental Data Records (Level 2) are fully processed sensor data that contain the geophysical parameters or imagery that must be generated as user products. All three levels of data records (RDRs, SDRs and EDRs) will be available to users.

The IDPS is being designed by Raytheon to process approximately 600 gigabytes of satellite data (RDRs) per day resulting in about 8 terabytes per day (3 terabytes per day for the NPOESS Preparatory Project) of data products (EDRs). To meet requirements for data latency, the IDPS must process 95% of the NPOESS data products within 5 minutes. The IDPS at each OPC will provide sufficient temporary storage capacity (i.e., storage capacity for multiple passes – minimum of 24 hour storage) to store the RDRs/SDRs/EDRs and ancillary data for immediate use in higher-level product applications. Two IDPS systems will be installed initially at NESDIS/NCEP and AFWA to support NPP. By the time the first NPOESS is available for launch in late 2009, IDPS systems will also be installed at FNMOC and NACOCEANO. NOAA's NESDIS will maintain the long-term archive of NPOESS data. NESDIS will also be responsible for providing access to the worldwide user community for near real-time processed NPOESS data and higher-level products.

Direct Broadcast Services

In addition to the space-to-ground transmission of SMD, NPOESS will simultaneously broadcast two continuous real-time data streams, at high and low rates, to suitably equipped field terminals worldwide. These direct broadcast/real-time field terminals will be capable of processing NPOESS RDRs into EDRs by using IDPS software appropriate for the type of field terminal. The NPOESS High Rate Data (HRD) broadcast will be a complete, full resolution data set containing all sensor data and auxiliary/ancillary data necessary to generate all NPOESS EDRs (except some Earth Radiation EDRs) and is intended to support users at fixed, regional hubs. The HRD systems will accept NPOESS data at 20Mbps in X-band frequencies using a ~2 meter tracking, receive antenna, and will produce 51 of the total 55 system EDRs. The NPOESS Low Rate Data (LRD) broadcast will be a subset of the full NPOESS sensor data set (29 of the 55 EDRs) and is intended for U.S. and worldwide users of field terminals (land and ship-based, fixed and mobile environmental data receivers operated by DoD users and surface receivers operated by other U.S. government agencies, worldwide weather services, and other international users). The LRD systems will receive data in L-band frequencies at 3.88Mbps using a ~1 meter antenna. The LRD broadcast will include data required to satisfy the U.S. user-specified, eight highest priority EDRs for real-time broadcast: imagery (from VIIRS) at 800 m horizontal resolution from at least one visible and one infrared channel and nighttime imagery at 2.7 km resolution from the day/night band; atmospheric vertical temperature and moisture profiles (from CrIS, ATMS, and CMIS); global sea surface winds (from CMIS); cloud base height, cloud cover/layers; pressure (surface/profile), and sea surface temperature. Transportable field terminal configurations are possible with either the HRD or LRD systems. Additional details on the NPOESS direct broadcast services are provided by Overton (2003).

Data Availability

Data from NPOESS satellites will be provided to users in accordance with U.S. policy. NPOESS will assure access to operational environmental data to meet civil and national security requirements and international obligations. During normal operations, NPOESS data will be broadcast without encryption for access by OPCs and field terminal users worldwide. However, NPOESS will be capable of encrypting selected mission data in all satellite links, excluding the SARSAT and A-DCS real-time downlinks, to selectively deny critical environmental data to an adversary during crisis or war yet ensure the use of such data by the U.S. and its Allies. While NPOESS is in a selective data encryption mode, the Operational Processing Centers will continue to receive and process NPOESS global SMD that will be available to the worldwide user community in non-real-time.

7. SUMMARY

The development of NPOESS represents a significant change in the way the United States acquires, manages, and operates environmental satellites. The advanced technology visible, infrared, and microwave imagers and sounders that will fly on NPOESS will deliver higher spatial and temporal resolution oceanic, atmospheric, terrestrial, climatic, and solar-geophysical data, enabling more accurate short-term weather forecasts and severe storm warnings. These data will be assimilated into the NWP models to improve short- (3-5 day) to medium- (7-15 day) range weather forecasts. The improved accuracy in atmospheric temperature and humidity soundings from these instruments, in combination with other observations expected to become available over the next ten years, will enable the current 3- to 5-day short-term weather forecasts to be improved from 70 to 80 percent to better than 90 percent and to be extended to 5 to 7 days with 80-percent accuracy. NPOESS data will be used by DoD, NOAA, and private weather services to assist military and civilian aircraft in planning and executing the safest, fastest, and most fuel efficient routes; direct oceanic and Great Lakes shipping away from ice and bad weather; and assist farmers, builders, utilities, and other businesses affected by the weather. Improved real-time monitoring capabilities of NPOESS will help federal, state, and local agencies to reduce economic and life/safety impacts of floods, droughts, severe storms, and other weather-related hazards. Ultimately, NPOESS will help us "take the pulse of Planet Earth" by providing continuity of critical data for monitoring, understanding, and predicting climate change and assessing the impacts of climate change on seasonal and longer time scales.

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